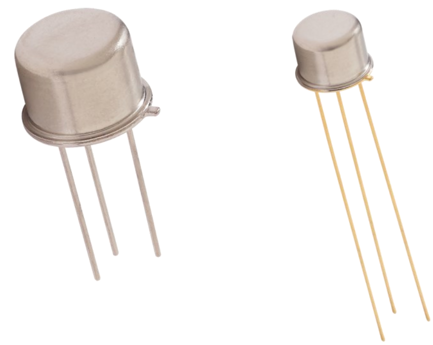
2N2904, 2N2904A, 2N2904AL
2N2905, 2N2905A, 2N2905AL

Radiation Hardened PNP Silicon Switching Transistors

Rev. V3

Features

- Qualified to MIL-PRF-19500/290
- Available in JAN, JANTX, JANTXV, JANS and JANSR
- Radiation Tolerant Levels M, D, P, L and R
- TO-39 and TO-5 package styles
- General Purpose Switching and Amplifier Applications



Electrical Specifications @ T_A = 25°C

Parameter	Test Conditions	Symbol	Units	Minimum	Maximum
Off Characteristics:					
Collector - Emitter Breakdown	I_C = -10 mA dc 2N2904, 2N2905 2N2904A, 2N2905A 2N2904AL, 2N2905AL	$V_{(BR)CEO}$	V dc	-40 -60 -60	—
Collector - Base Cutoff Current	V_{CB} = -60 V dc	I_{CBO1}	µA dc	—	-10
Collector - Base Cutoff Current	V_{CB} = -50 V dc 2N2904, 2N2905 2N2904A, 2N2905A 2N2904AL, 2N2905AL	I_{CBO2}	nA dc	—	-20 -10 -10
Emitter - Base Cutoff Current	V_{EB} = -5.0 V dc	I_{EBO1}	µA dc	—	-10
Emitter - Base Cutoff Current	V_{EB} = -3.5 V dc	I_{EBO2}	nA dc	—	-50
Collector-Emitter Cutoff Current	2N2904, 2N2905; V_{CE} = -40V dc 2N2904A, 2N2904AL; V_{CE} = -60V dc 2N2905A, 2N2905AL; V_{CE} = -60V dc	I_{CES}	µA dc		1 1 1

1. Pulse Test: Pulse Width = 300 us, Duty Cycle < 2%.

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For further information and support please visit:
info@vptcomponents.com

Parameter	Test Conditions	Symbol	Units	Minimum	Maximum
On Characteristics:					
Forward Current Transfer Ratio	V_{CE} = -10 V dc, I_C = -0.1 mA dc 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	h_{FE1}		20 35 40 75	
Forward Current Transfer Ratio	V_{CE} = -10 V dc, I_C = -1.0 mA dc 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	h_{FE2}		25 50 40 100	175 450 175 450
Forward Current Transfer Ratio	V_{CE} = -10 V dc, I_C = -10 mA dc 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	h_{FE3}		35 75 40 100	
Forward Current Transfer Ratio	V_{CE} = -10 V dc, I_C = -150 mA dc 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	h_{FE4}		40 40 100 100	120 120 300 300
Forward Current Transfer Ratio	V_{CE} = -10 V dc, I_C = -500 mA dc 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	h_{FE5}		20 30 40 50	
Collector - Emitter Voltage (Saturated)	I_C = -150 mA dc, I_B = -15 mA dc I_C = -500 mA dc, I_B = -50 mA dc	$V_{CE(sat)1}$ $V_{CE(sat)2}$	Vdc	—	-0.4 -1.6
Base - Emitter Voltage (Saturated)	I_C = -150 mA dc, I_B = -15 mA dc I_C = -500 mA dc, I_B = -50 mA dc	$V_{BE(sat)1}$ $V_{BE(sat)2}$	Vdc	—	-1.3 -2.6

Electrical Specifications (T_A = 25°C unless otherwise specified)

Parameter	Test Conditions	Symbol	Units	Minimum	Maximum
Collector-Base Cutoff Current	T_A = +150°C V_{CB} = -50 V dc 2N2904, 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	I_{CBO3}	µA dc		-20 -10 -10
Small-Signal Short-Circuit, Forward Current Transfer Ratio	T_A = -55°C V_{CE} = -10 V dc, I_C = -1.0 mA dc 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	h_{fe6}		15 30 20 50	—

Parameter	Test Conditions	Symbol	Units	Minimum	Maximum
Dynamic Characteristics:					
Small-Signal Short-Circuit Forward Current Transfer Ratio	V_{CE} = -20 V dc, I_C = -50 mA dc, f = 100 MHz	$\|h_{fe}\|$		2.0	
Small-Signal Short-Circuit, Forward Current Transfer Ratio	V_{CE} = -10 V dc, I_C = -1 mA dc, f = 1 kHz 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	h_{fe}		25 50 40 100	—
Open Circuit Output Capacitance	V_{CB} = -10 V dc, I_E = 0, 100 kHz ≤ f ≤ 1 MHz	C_{obo}	pF	—	8
Input Capacitance (Output Open-circuited)	V_{EB} = -2.0 V dc, I_C = 0, 100 kHz ≤ f ≤ 1 MHz	C_{ibo}			30
Switching Characteristics:					
Turn-On Time	(See figure 6 of MIL-PRF-19500/291)	t_{on}	ns	—	45
Turn-Off Time	(See Figure 7 of MIL-PRF-19500/291)	t_{on}	ns	—	300

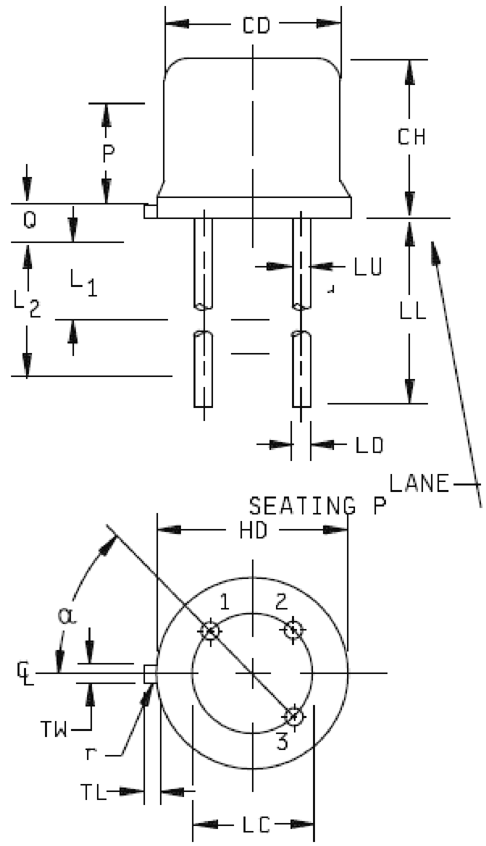
Absolute Maximum Ratings (T_A = 25°C unless otherwise specified)

Ratings	Symbol	Value
Collector - Emitter Voltage 2N2904, 2N2905 2N2904A, L; 2N2905A, L	V_{CEO}	 -40 V dc -60 V dc
Collector - Base Voltage	V_{CBO}	-60 V dc
Emitter - Base Voltage	V_{EBO}	-5.0 V dc
Collector Current	I_C	-600 mA dc
Total Power Dissipation @ T_A = +25°C	P_T (1)	0.8 W
Total Power Dissipation @ T_C = +25°C	P_T (2)	3.0 W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (1) (2)	195°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$ (1) (2)	50°C/W
Operating & Storage Temperature Range	T_J, T_{STG}	-65°C to +200°C

Notes: (1) For derating, see figure 2 and figure 3 of MIL-PRF-19500/290
(2) For thermal impedance, see figure 4 and figure 5 of MIL-PRF-19500/290

Outline Drawing (TO-39)

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		6
LD	.016	.019	0.41	0.48	7, 8
LL	.500	.750	12.70	19.05	7, 8, 12
LU	.016	.019	0.41	0.48	7, 8
L_1		.050		1.27	7, 8
L_2	.250		6.35		7, 8
P	.100		2.54		
Q		.050		1.27	5
TL	.029	.045	0.74	1.14	4
TW	.028	.034	0.71	0.86	3
r		.010		0.25	10
α	45° TP		45° TP		6

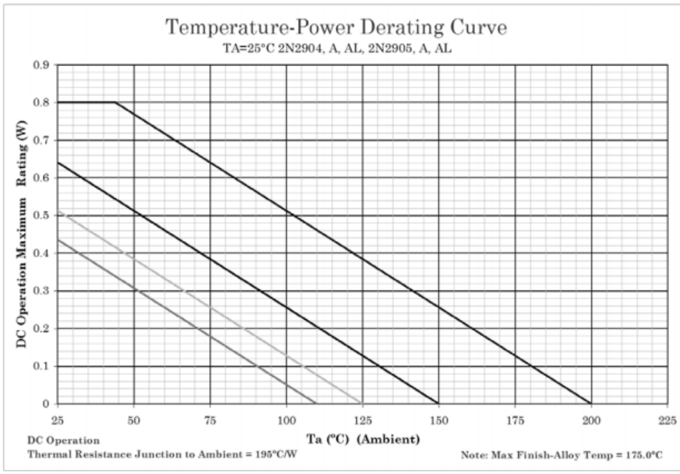


NOTES:

1. Dimension are in inches.
2. Millimeters are given for general information only.
3. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001, -.000 inch (1.37 +0.03, -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods.
7. Dimension LU applies between L_1 and L2. Dimension LD applies between L2 and L minimum. Diameter is uncontrolled in L_1 and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
12. For "L" suffix devices, dimension LL is 1.50 (38.10 mm) minimum, 1.75 (44.45 mm) maximum.
13. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

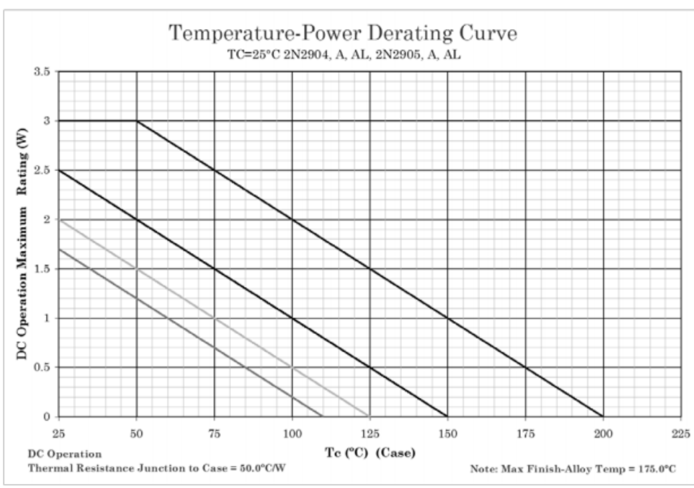
FIGURE 1. Physical dimensions (similar to TO-39).

Temperature-Power Derating Curves



NOTES:
1. All devices are capable of operating at ≤ T_J specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature (T_J ≤ 200°C) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at T_J ≤ 150°C, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at T_J ≤ 125°C, and 110°C to show power rating where most users want to limit T_J in their application.

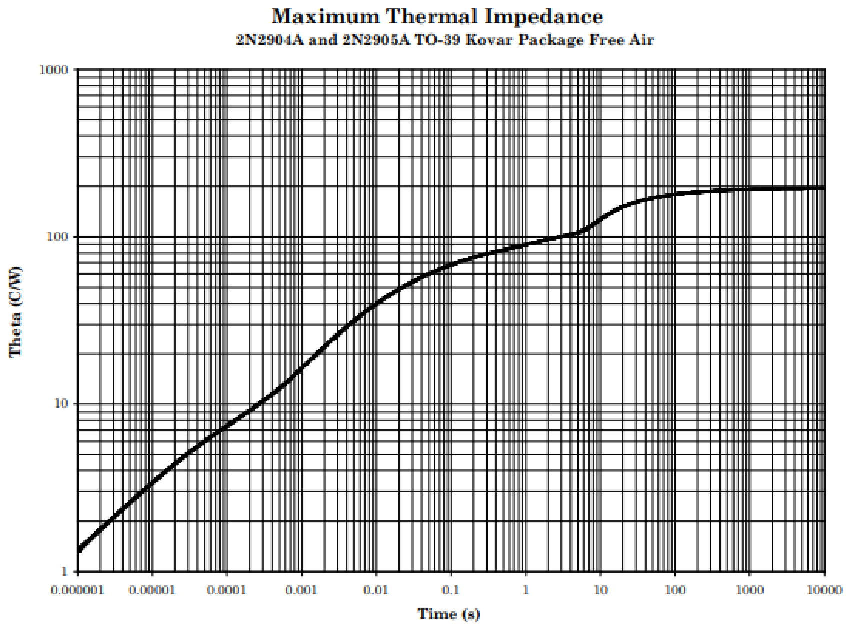
FIGURE 2. Derating for 2N2904, 2N2904A, 2N2904AL, 2N2905, 2N2905A, 2N2905AL, ($R_{\theta JA}$) PCB (TO-39).



NOTES:
1. All devices are capable of operating at ≤ T_J specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature (TJ ≤ 200°C) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at T_J ≤ 150°C, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at T_J ≤ 125°C, and 110°C to show power rating where most users want to limit T_J in their application.

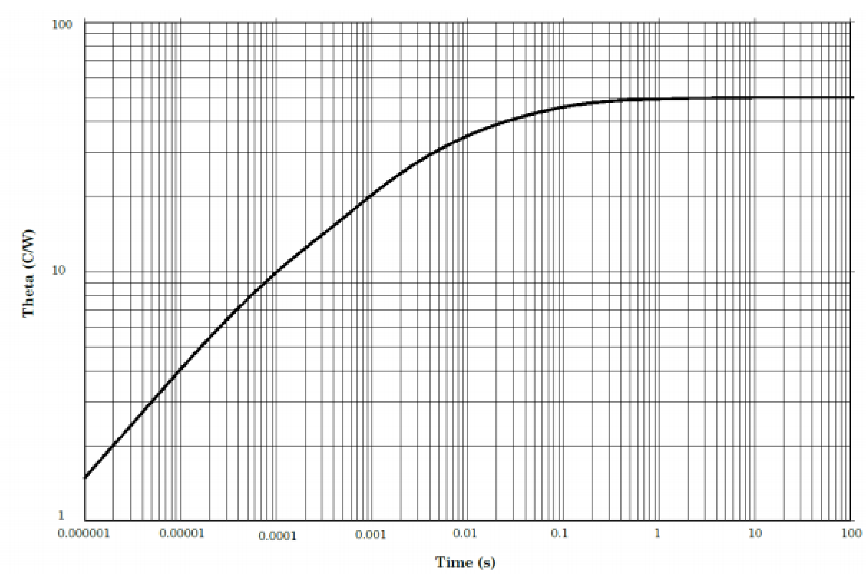
FIGURE 3. Derating for 2N2904, 2N2904A, 2N2904AL, 2N2905, 2N2905A, 2N2905AL, ($R_{\theta JC}$) PCB (TO-39).

Thermal Impedance Curves



Ambient free air cooled T_A = +25°C, 800mW, thermal resistance $R_{\theta JA}$ = 195°C/W.

FIGURE 4. Thermal impedance graph ($R_{\theta JA}$) for all 2N2904, and 2N2905 devices (TO-39).



Ambient case mounted T_C = +25°C, thermal resistance $R_{\theta JC}$ = 50°C/W.

FIGURE 5. Thermal impedance graph ($R_{\theta JC}$) for all 2N2904, and 2N2905 devices (TO-39).